Association between Trunk Flexion and Physical Activity in Patient Care Unit Workers

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The purpose of this pilot study was to characterize the direct measure of physical activity levels and the trunk posture (as a proxy for physical load) among a convenience sample of 49 Patient Care Unit workers (nurses and patient care assistants) for a single work shift. We tested the hypotheses that Patient Care Unit (PCU) worker's increased trunk posture is associated with their direct measure of physical activity levels during one work-shift. To assess the physical activity and physical load component all participants wore an accelerometer and an inclinometer respectively. A correlation analysis was performed to assess the association between parameters of physical activity (minutes in sedentary activity, minutes in lifestyle activity, minutes in light activity and minutes in moderate activity) with parameters of physical load (number of forward trunk bends to 20˚ per shift, number of forward trunk bends to 45˚ per shift). Workers were recruited from two hospitals in Boston, Massachusetts. Eleven participants spent 86% of the time at work with a trunk flexion lower than 15˚, they were considered at low exposure for back disorders. Seven PCU workers spent 33% of their work time with a trunk flexion higher than 20˚, they were considered at high exposure. Twenty-one workers were classified at a medium exposure for back disorders. A high correlation was found between number of forward trunk bending to 20˚ per shift (spearman's correlation: 0.56, $p<0.001$) with minutes in lifestyle activity. In addition, a high correlation was found among number of forward trunk bending to 45˚ per shift with minutes in lifestyle activity and minutes in light activity (spearman's correlation: 0.41, $p=0.005$ and 0.37, $p=0.01$ respectively). These results suggest that physical load at work during a single shift does not contribute to meet moderate or vigorous activity levels which are the activity levels that have substantial health benefits. Further studies with a bigger sample size would be recommended to assess the association between physical loads and physical activities for more than one shift to corroborate our findings.

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Patient Care Unit (PCU) workers have a high prevalence of musculoskeletal complains (Stubbs, Buckle et al. 1983; Jensen 1990; Yip 2004). They are exposed to physical demands at work that include patient handling tasks such as lifting, repositioning and manual transferring. These tasks are physically demanding and impose mechanical loads that increase the probability for the development of low back pain and disability (Jensen 1990; Marras, Davis et al. 1999; Village, Frazer et al. 2005). Bending of the torso puts large strains on the low back and trunk bending measured using an inclinometer has been affiliated with increase risk of low back pain (Fathallah, Marras et al. 1998; Fathallah, Marras et al. 1998; Teschke, Trask et al. 2009)).

Physical inactivity has been identified as the second modifiable lifestyle-related behavior that contributes to death in the United States(Mokdad, Marks et al. 2004). In addition, the World Health Organization (WHO 2010) has identified it as the fourth leading risk factor for global mortality. Physical inactivity has been associated with an increased risk of morbidity or worsening of many medical conditions (Samitz, Egger et al. 2011). While increased levels of physical activity are associated with reduced all-cause mortality, physically demanding jobs are often associated with increase rates of chronic disease (Tuomi, Ilmarinen et al. 1991; Holtermann, Mortensen et al. 2010). For these physically demanding jobs the relationship between the physical demands of a job and the physical activity one gets at work is unknown.

PCU workers in acute-care hospitals have certain physical demands at work including patient handling and caring for multiple patients within a hospital ward. Therefore, our goal was to characterize the physical load and physical activity during a single shift of a convenient sample of PCU workers in an acute-care hospital setting. In this pilot study, we characterized the direct measure of physical activity levels and the trunk bending posture in a convenience sample of Patient Care Unit workers (Nurses and Patient Care Assistant) for a single work shift. We tested the hypotheses that PCU worker's increased trunk posture is associated with their direct measure of physical activity levels during one work-shift.

Methods

Participants

A total of fifty PCU workers (40 nurses and 10 patient care assistants) employed in two urban acute care hospitals in Boston, Massachusetts participated in this study. Due to download errors we lost data on one of the participants. From the final sample, 9 participants (18%) were patient care assistants and 40 (82%) were nurses. 43 were females and 6 were males. Their ages ranged from 23 to 68 years, with a mean of 42.5+-12.3 years. Thirty five participants worked during day shifts (from 7 am to 11 pm) and fifteen in night shifts (from 7 or 11 pm to 7 am).

Workers were recruited from the thoracic intensive care unit, orthopedic, burn and trauma, cardiac and cardiac step-down units. The nursing leadership and Unit Nurse Directors identified and selected these units for participation in this study based on previous concerns about musculoskeletal disorders within these units. At the time of the study, workers were employed in an inpatient patient care unit with a nurse manager/director. Directors/managers of these units volunteered and agreed to participate in the study. PCU workers who were employed in outpatient units, pediatric and newborn units (where physical loads were considered lower) or emergency rooms and operating rooms (where the patient were eventually discharged or transferred to another unit) were not eligible to participate. All participants provided written informed consent prior to data collection. This study was approved by the Human Research Ethics boards at Partners Health, Boston, MA.

Study Measures

For this study, we collected information on PCU worker's age, gender, weight, occupation type, and type of work shift. We also measured and documented the worker's risk for back disorders, torso bending and physical activity levels.

Categorizing exposure measures

We categorized the exposure for back disorders as high, medium and low exposures. Low exposure for back disorders were classified as trunk flexion < 15˚ during 86% of the work shift (Fathallah, Marras et al. 1998). High exposure for back disorders was defined as keeping a trunk flexion >20˚ during 33% of the work shift (Punnett, Fine et al. 1991; Keyserling, Brouwer et al. 1992). All other trunk flexion postures were classified as medium risk (Figure. 1).

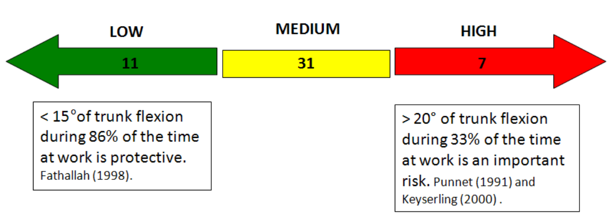

Figure 1. **Exposure classification for Back Pain**

Trunk posture

We measured trunk flexion in a single 8 – 12 hour shift using triaxial accelerometer data-loggers. This inclinometer device (G-Link Data Loggers; G-Link 2.4 GHx Wireless, Microstrain, Inc; Williston, VT, USA) measured the subject's torso posture related to the sagittal plane while performing their usual work tasks at five samples per second (5Hz). The trunk postural data logger was placed on each participant's torso centered below the C7 vertebrae. A reference posture was established for each participant at the beginning of data collection. The reference posture protocol includes an initial three slow bows (or push-ups against the wall if they cannot bow) while standing with their feet shoulder width apart with their back straight, and hands at their sides, and holding this position for 10 seconds. Then participants were instructed to perform one additional slow bow (or push up against the wall) and, finally three slow bows. This reference calibration point maneuver allowed us to align accelerometer axes by recording data during the reference posture movement and to calculate trunk angles with respect to the reference posture.

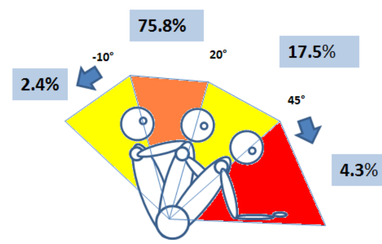

Figure 2. **Percentage of the working time at different trunk postures**

Data processing for Torso bending

The torso bending data was synchronized with the data collected from the accelerometer device in order to identify the data sections that corresponded to the PCU's workers day shift. The postural data were then categorized into 4 groups of trunk flexion (1) <-10°, (2) -10° to 20°, (3) > 20° to 45°, and (4)> 45°. We then calculated the time (duration) in each category and the frequency of bending per hour within categories.

Physical Activity

To measure physical activity, all participants wore an accelerometer (ActigraphGT3X, LLC; Ft. Walton Beach, FL) over the right hip on an elasticized belt during the single shift. Accelerometer assesses accelerations ranging from 0.05-2.0 G and is band limited with a frequency response from 0.25-2.5 Hz. The Actigraph then records and calculates counts of activity for each minute and the number of steps (Freedson, Melanson et al 1998). Once synchronized to the reference posture, physical activity data were parsed and grouped. Steps, mean counts, and minutes spent for different levels of physical activity based on definitions of intensity levels (Freedson, Melanson et al. 1998) were determined where the count met the criterion. These levels include sedentary (0-100 counts per minute), lifestyle (101-759 counts per minute), light (760-1952 counts per minute), moderate (1953-5724 counts per minute), vigorous (5725-9498 counts per minute), and very vigorous (≥9498 counts per minute).

Statistical Analysis

To test the hypothesis that a PCU worker's increased trunk posture is associated with their direct measure of physical activity levels during one work-shift; correlation analysis was performed exploring the association between physical activity and different metrics for physical load. The statistical analysis was performed in STATA 11(StataCorp, College Station, TX)

Results

PCU workers spent 73.6% of their work time in a trunk posture between -10° to 20° and 18.5% between 20° to 45°. More extreme trunk postures were found in 3.4% ° and 4.5% for trunk postures < -10˚and >45° respectively. Eleven participants spent 86% of the time at work with a trunk flexion lower than 15˚ , they were considered at low risk for back disorders according to Fathallah's criteria (Figure 1). Seven PCU workers spent 33% of their work time with a trunk flexion higher than 20˚ , they were considered at high risk according to Punnet and Keyserling criteria (Figure 1). Twenty-one workers were classified at a medium risk for back disorders. Participants who were at high risk for back disorders had a high frequency of trunk bending per hour compared to those at low risk.

A correlation analysis was performed to assess the association between parameters of physical activity (minutes in sedentary activity, minutes in lifestyle activity, minutes in light activity and minutes in moderate activity) with parameters of physical load (number of forward trunk bending to 20˚ per shift, number of forward trunk bending to 45˚ per shift). None of the participants had vigorous or very vigorous levels of physical activity (Table 1).

Table 1. Spearman correlations and p-values among different parameters of physical activity and physical load.

Physical activity parameters / Physical load parameters	Minutes in sedentary activity		Minutes in lifestyle activity		Minutes in light activity		Minutes in moderate activity	
	Corr	p	Corr	p	Corr	p	Corr	p
Number of forward trunk bends to 20˚per shift	0.21	0.15	0.56	<0.001	0.27	0.07	0.21	0.16
Number of forward trunk bends to 45˚per shift	0.08	0.6	0.41	0.005	0.37	0.01	0.16	0.27

High correlation 0.41 - 0.6 , $0.0001<p<0.01$ Low correlation 0.2-0.3, $0.05 < p<0.20$ No correlation

A very high correlation (corr) was found between number of forward trunk bending to 20˚ degrees per shift (spearman's corr: 0.56, p=<0.001) with minutes in lifestyle activity. A high correlation were found among number of forward trunk bends to 45˚ degrees per shift with minutes in lifestyle activity and minutes in light activity (spearman's corr: 0.41, p=0.005 and 0.37, p=0.01respectively). Number of forward trunk bends to 20˚ degrees per shift showed a low correlation with minutes in sedentary activity, light activity and moderate activity.

Discussion

We aimed to characterize the physical load and physical activity during a single shift of typical workers in a patient care unit (PCU) and then test the hypothesis that the metrics of physical load are associated with metrics of physical activity. Of the PCU workers 14.3% (7) were at high risk for back disorders and 63.3% (31) at medium risk according to Fathallah, Punnet and Keyserling criteria.

Consistent with our hypothesis, the results of the correlation analysis showed that the number of forward trunk bends to 20˚ and 45˚ per shift were positive and linearly correlated with minutes in lifestyle activity (spearman's corr: 0.56, p<0.001 and 0.41, p= 0.005, respectively). Number of forward trunk bends to 45˚ per shift, were also high correlated with minutes in light activity (spearman's corr: 0.37, p= 0.01). These results suggest that physical load at work during a single shift, do not contribute to meet moderate or vigorous activity levels which are the activity levels that have substantial health benefits.

While there was an association between trunk flexion and physical activity, the physical activity was only lifestyle activity level. Hence, this physical activity level is below the recommended levels for substantial health benefits according to the World Health Organization (WHO 2010). For recommended levels of moderate and vigorous intensity we find no correlation between physical activity and physical load.

A limitation of our study was that data we collected were from a single work shift in two specific hospitals in Boston. This may limit the generalizability of the results to PCU workers that share similar characteristics in terms of job demands, job practices, and availability of patient mechanical assistive technologies such as ceiling lifts and/or patient hoist.

The use of trunk flexion as a proxy of physical load was a novel strategy to overcome technical limitations of measuring trunk loads in a hospital setting. Laboratory measures of physical load would be a more precise method but are unfeasible to perform in a real PCU worker environment. Physical activity was measured using a validated methodology that gave a reliable parameter. These two physical factors alone are relevant given they are linked to workers' health and wellbeing. This comprehensive approach to workers health will contribute to improve our understanding of the interaction between physical activity levels and physical load in a dynamic and physically demanding work environment such as a hospital setting. If we understand this interaction, we can comprehend how to improve key message for integrated physical activity and ergonomic interventions. Further studies with a bigger sample size and multiple measures per workers during work days would be recommended to assess the association between physical loads and physical activities for more than one shift and corroborate our findings.

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